

**QUARTERLY TECHNICAL PROGRESS REPORT**

**Cooperative Agreement No. DE-FC26-00NT40804**

**Project Title:**

**DESIGN, FABRICATION, AND TESTING OF AN ADVANCED, NON-POLLUTING  
TURBINE DRIVE GAS GENERATOR**

**REPORT PERIOD: 1 APRIL 2002 THRU 30 JUNE 2002**

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## ABSTRACT

The objective of this report period was to continue the development of the Gas Generator design, completion of the hardware and ancillary hardware fabrication and commence the Test Preparations for the testing of the non-polluting unique power turbine driven Gas Generator. Focus during this report period has been on completing the Gas Generator fabrication of hardware and ancillary hardware, and completion of unit closeout brazing and bonding. Because of unacceptable delays encountered in a previously competitively selected test site, CES initiated a re-competition of our testing program and selected an alternate test site. Following that selection, CES used all available resources to make preparations for testing the 10 Mw Gas Generator at the new testing site facilities of NTS at Saugus, CA.

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**QUARTERLY TECHNICAL PROGRESS STATUS REPORT**  
**For the period ending 31 July 2002**  
**FOR DOE/NETL GAS GENERATOR TEST PROGRAM**

**30 JULY 2002**

**CONTRACT STATUS**

The following contract activities occurred during this report period:

1] CES and AEROJET [sub-contractor for fabrication of platelets hardware] completed a letter contract for fabrication of the Gas Generator platelet injectors for the NETL 10 Mw Gas Generator Test Program. These contract activities completed an agreement entered during the previous report period with a negotiated Contract 2001-1 signed on 1/24/02.

Fabrication activities by AEROJET during this report period were timely and responsive and their performance was very good.

2] CES and AEROJET [sub-contractor for testing] agreed to terminate the AEROJET contract for any further testing by AEROJET on the 10 Mw Gas Generator Test with the issuance of a “stop work order” on the Testing Preparations. CES then issued RFP’s [Request For Bid] for completing the remaining testing portion of the 10 Mw Gas Generator Program. After subsequent review of the various RFP’s, CES selected National Technical Services [NTS] as the new sub-contractor for testing and awarded the testing sub-contract to NTS on 5/15/02. NTS is located in Saugus, CA. See SUB-CONTRACTOR ACTIVITIES for more details.

3] CES and TECMA [sub-contractor for fabrication of the Gas Generator and ancillary hardware] completed negotiating the fabrication fixed-price Contract 2000-1 dated 3/28/02 and executed on 4/4/02 for fabricating all Gas Generator hardware and ancillary hardware except for the Gas Generator platelet hardware which AEROJET [sub-contractor for fabrication of platelets hardware] fabricated.

Fabricating activities by TECMA neared completion and all spare hardware will be completed by early August 2002. The one [1] remaining item in fabrication is the spare Combustion Chamber, which is not affecting the testing schedule.

## **PROGRAM MANAGEMENT STATUS**

The Test Plan dated June 2000, which had been approved by DOE/NETL for the 10 Mw Gas Generator Test Program, was updated and revised to reflect the Gas Generator finalized design and testing requirements. The revised Test Plan, dated August 2001, was sent to NETL [Thomas J George] under separate cover. This revised Test Plan was submitted to AEROJET [sub-contractor for testing] for their evaluation and updating of their original proposal bid.

However, a revised version of this Test Plan, which eliminates the Igniter Assembly Testing portion of the Test Plan, was utilized for obtaining new RFP [request for proposal] bids from the test facilities sub-contractors. See SUB-CONTRACTOR ACTIVITIES for more details.

## **SCHEDULE STATUS**

With the selection of the new testing sub-contractor, NTS, CES now expects the 10 Mw Gas Generator testing to begin in early August 2002, and be completed by mid-September 2002. CES expects a "DRAFT" Final Report to be submitted to NETL on 12 October 2002 and the Final Report to be submitted to NETL on or before 30 November 2002.

A "revised" schedule has been created and attached to this quarterly report to reflect CES/NTS current revised 10 Mw Gas Generator testing schedule and the schedule for the conduct of the technical review meetings i.e. Test Readiness Review [TRR] and the Process Safety Hazard Analysis [PSHA]. See Schedule No. 1 Titled: Overview Schedule for 10 MW Gas Generator Test Program [7/19/02].

## **SUB-CONTRACTOR ACTIVITIES**

CES's sub-contractor for the fabrication of the platelet hardware, AEROJET, has completed all of their scheduled fabrication activities during this report period for the 10 Mw Gas Generator Program. TECMA, Inc., sub-contractor for fabrication of the majority of the Gas Generator hardware and ancillary hardware is also nearing completion of their fabrication activities and has one [1] remaining item of spare hardware to be completed. The remaining piece of hardware is the spare Combustion Chamber [CC], which is not affecting the testing schedule and will be completed by early August before testing commences.

CES' sub-contractor for testing of the 10Mw Gas Generator System, AEROJET, was given a "stop work order" after a successful completion of the Igniter Assembly testing. The "stop work order" was issued after AEROJET had slipped the schedule for testing the major portion of the 10 Mw Gas Generator Program. A new testing sub-contractor, NTS [National Technical Services], located in Saugus, CA. has been selected after CES re-issued new RFP's for the remainder of the testing program.

Four [4] testing facilities sub-contractors were invited to bid on the RFP and three [3] submitted bids.

CES's new sub-contractor for testing, NTS and CES commenced in necessary test preparations during this report period. NTS has commenced configuring their testing facility for testing the 10 Mw Gas Generator. Test facility hardware has been configured, modified and assembled to perform this test program.

CES has shipped all the necessary Gas Generator test hardware and ancillary hardware to NTS where it is assembled and readied for testing. See Figure 1: Assembled Gas Generator. The pretest instrumentation of the Gas Generator should be completed by the end of July 2002. Subsequently, cold-flow testing and hot-fire testing, of the various Gas Generator configurations will be conducted. See Schedule No.1 Titled: Overview Schedule for 10 MW Gas Generator Test Program dated 7/19/02, for details.

#### RELATED PROGRAM ACTIVITIES

CES uses available opportunities to report the nature and progress of CES' work. CES is seeking appropriate opportunities to meet with interested audiences at both domestic and international conferences and make appropriate presentations.

During this report period there were no public presentations at organized conferences, due in part to CES' participation in two [2] conferences during the preceding quarter. During this quarter, CES did make several presentations directly to interested parties including: the Sacramento Municipal Utility District, the Los Angeles Department of Water and Power, Calpine, AES, Air Products, Praxair, and several other companies and organizations. In each case, these parties were provided with overviews of this program. CES also briefed several Brazilian public and private sector companies during a trip in June.

On August 20, 2001 Elliott Turbomachinery, of Jeannette, PA, and CES signed a non-binding Letter of Intent. This document identifies different collaborative opportunities for CES and Elliott, with the expectation of identifying new mutually beneficial opportunities for each company. The letter contains mutual undertakings, among the most significant of which are: [1] the companies will exchange information and analyses concerning different plant cycles and configurations, and [2] using CES provided basic design criteria for "near term" turbines [i.e. within 5 years] Elliott will undertake design of a high pressure, high temperature turbine of a nominal 16 MW size with inlet conditions of approximately 1500 psig and 1500<sup>0</sup>F. An associated nominal 35 MW intermediate turbine will have inlet conditions [after reheat] of 365 psig and 2200<sup>0</sup>F. An expected nominal 17 MW low- pressure turbine in this series will have inlet conditions of 17 psig and 1200<sup>0</sup>F.

For each turbine, Elliott is to prepare a detailed development schedule, indicating the critical path to commercialization, the inputs required from CES, and the estimated program costs. In April 2002, CES personnel visited the Elliott plant, in Jeannette, and received a progress report on the work to date. Preliminary design work and preliminary material selection have been accomplished. 3-D ProE modeling and evaluation of the turbines steam end are being reviewed for influence on the selection of casing materials. Candidate materials for the turbine rotating and stationary bucketing have been investigated, but no definitive design has been established yet. Elliott has two [2] full-time engineers committed to this project and is seeking additional internal funding to advance the program. Preliminary proprietary configuration drawings have been produced and have been seen by CES.

The availability of higher pressure, higher temperature steam turbines will be a significant contributor to early realization of higher efficiencies in plants using CES technology. This will be an important part of CES's pathway to market rationale.

CES achieved several milestones with respect to the 500 kW demonstration plant, which is partially co-funded by the California Energy Commission, Air Liquide, and Mirant Corporation. During this report period permits or waivers were received for air, water, and land use for the project site in Antioch, California. Also, the Project Design Book was completed, and submitted to and approved by the CEC.

CES is also working on several commercial-scale projects [20 MW to 70 MW] with utilities and oil companies interested in enhanced oil recovery uses of CO<sub>2</sub>. Development of these projects is expected to continue into 2003.

## **TECHNICAL STATUS**

### **DESIGN STATUS**

As indicated in the previous quarterly reports, design work on the 10 MW Gas Generator is completed.

### **FABRICATION STATUS**

Fabrication of the 10 MW Gas Generator hardware and ancillary hardware has been completed and a spare combustion chamber, a spare injector assembly and a spare cool-down chamber were essentially complete at the end of this reporting period.

### **TESTING STATUS**

The test article has been delivered to the test site [NTS] and instrumentation was being assembled at the end of this report period. Testing is expected to conclude in the next report period.

## **DELIVERABLES STATUS**

This 7<sup>th</sup> Quarterly Technical Progress Report and the Seventh Financial Status Report will be submitted to NETL on 30 July 2002

## **ASSESSMENT OF OVERALL PROJECT OBJECTIVES**

The Igniter Assembly Testing was completed successfully during the last report period. However the testing of the main Gas Generator Assembly has slipped again until the August 2002 time frame with no specific completion date. This slip in the Gas Generator Assembly testing requires a Contract Extension from 5/7/02 to 30 November 2002. A tentative schedule for performing the Gas Generator Testing Program has been attached to this Technical Progress Report as Schedule No. 1: Overview Schedule for 10 MW Gas Generator Test Program.

CES has submitted to NETL a Contract Revision due to a projected cost overrun and stretchout to the program. Initial written notification of these two [2] items occurred on 4/16/02, when both Tom J. George, NETL's Project Manager and CES' [COR] & Lisa Kuzniar, NETL's Contract Specialist were notified.

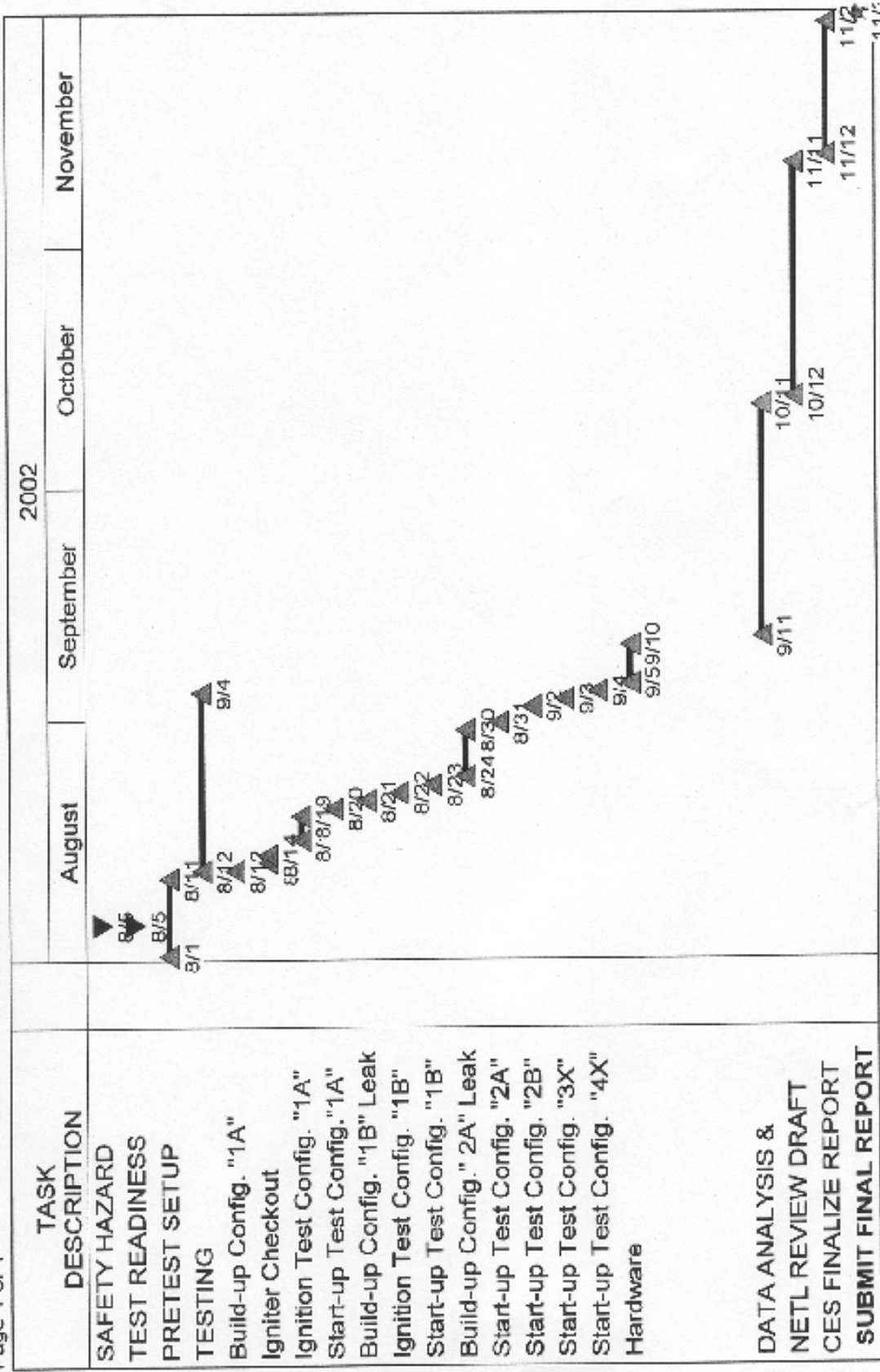
## **RESULTS & DISCUSSION**

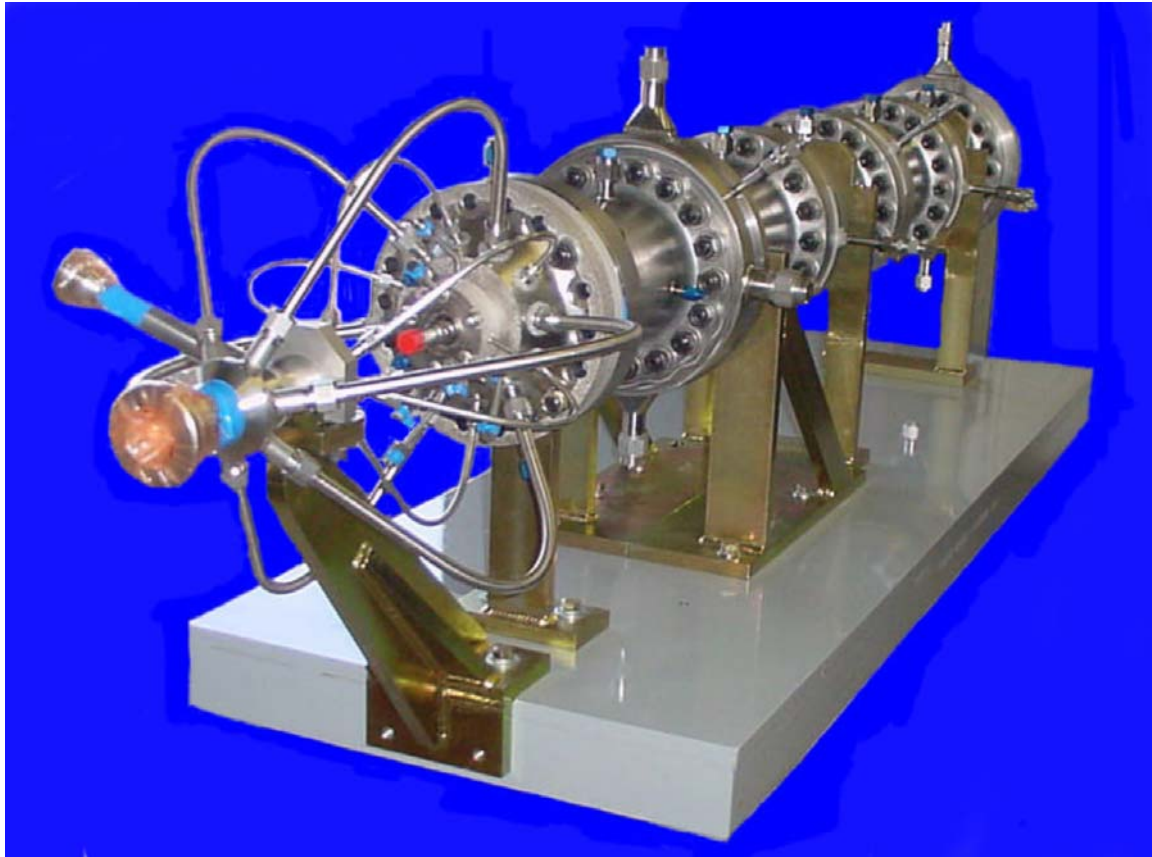
This program has completed the design and the fabrication phases of the 10 Mw Gas Generator Program, with the exception of the one [1] spare combustion chamber which should now be completed by early August 2002, and will not impact the testing phase of the program. The Testing Preparations are nearing completion by NTS/CES.

## **CONCLUSIONS**

Although the test schedule has slipped, all technical aspects of the design and fabrication phases are essentially complete. Test preparations are in progress and testing should be completed during the next report period. All program objectives are expected to be achieved.

Note: “This Technical Progress Report was prepared with the support of the U. S. Department of Energy under Award No.DE-FC26-00NT40804. However, any opinions, findings, conclusions, or recommendations expressed herein are those of the author[s] and do not necessarily reflect the views of the DOE.”





**Figure1**  
**10 MW Gas Generator**